890

mi Sanders

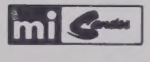
6055

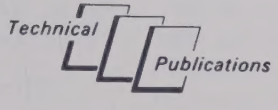
Signal Source

INSTRUCTION MANUAL

MARCONI INSTRUMENTS LTD.
SANDERS DIVISION STEVENAGE

INSTRUCTION MANUAL
for
SIGNAL SOURCE
TYPE 6055





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SANDERS DIVISION

STEVENAGE HERTFORDSHIRE ENGLAND

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Chapter 1

General information

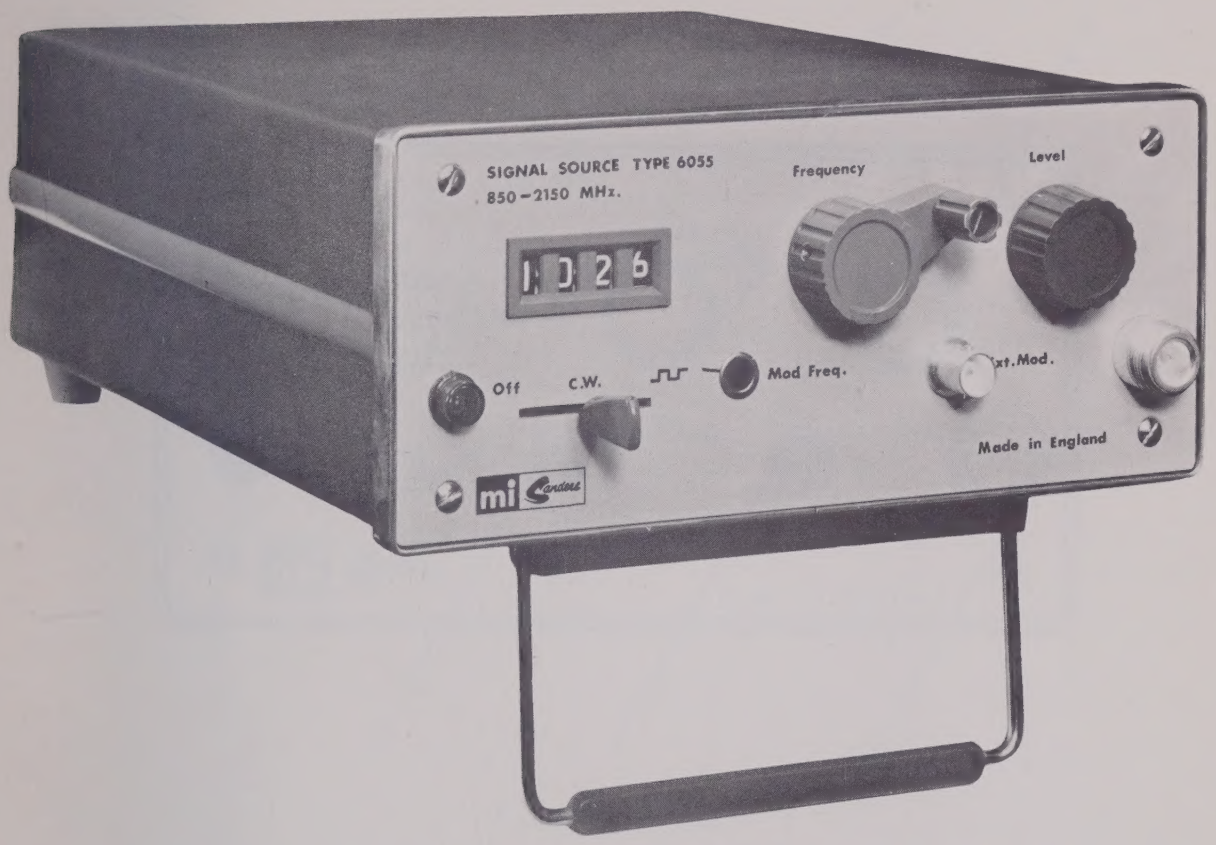

Fig. 1. M.I. Sanders Signal Source Type 6055

1.1 SPECIFICATION

Frequency Range:	850 – 2150MHz
Power Output:	Greater than 10mW into 50Ω
Calibration Accuracy:	1%
Harmonic Content:	> 20dB below fundamental
Attenuator Range:	> 25dB
Ex. Mod. Range:	> 25dB for 20V input
Int. Mod:	100% mod. 900 – 1100Hz or 2.9 – 3.1kHz
Power Requirements:	200 – 250V AC 100 – 125V AC 50 – 60Hz
Size:	$3\frac{7}{8}$" (97,16mm) 8" (203,2mm) 11¼" (285,75mm) (min)
Weight:	10¼ lb (4,65kg)

1.2 INTRODUCTION

The MI–Sanders Signal Source Type 6055 is the first in a line of solid state replacements for low power triode and klystron oscillators.

This model covers the range 850 to 2150MHz with a minimum output of 10mW into 50 ohm. Power output over most of the range is generally in excess of 60mW.

The r.f. power can be modulated internally by a 900 – 1100Hz square wave applied to the base of the transistor or externally using an integrally mounted diode attenuator. This attenuator can be used to level the output using an external coupler and detector, or can be used to attenuate the r.f. output using the front panel level control. The attenuation range in both internal and external modes is in excess of 25dB.

A facility which increases the usefulness of the source is a rear panel 0–20V output proportional to frequency. This can be used in conjunction with an X-Y recorder to provide permanent records of swept frequency measurements.

1.3 INSTALLATION

The Type 6055 is a self contained unit with the mains input at the rear. Before switching on check that the rear panel voltage switch is set to the appropriate value and that the correct fuse (250mA) is fitted.

The unit can be mounted in any position, but care should be taken to allow air to circulate freely over the rear panel heat sink.

Chapter 2

Operation

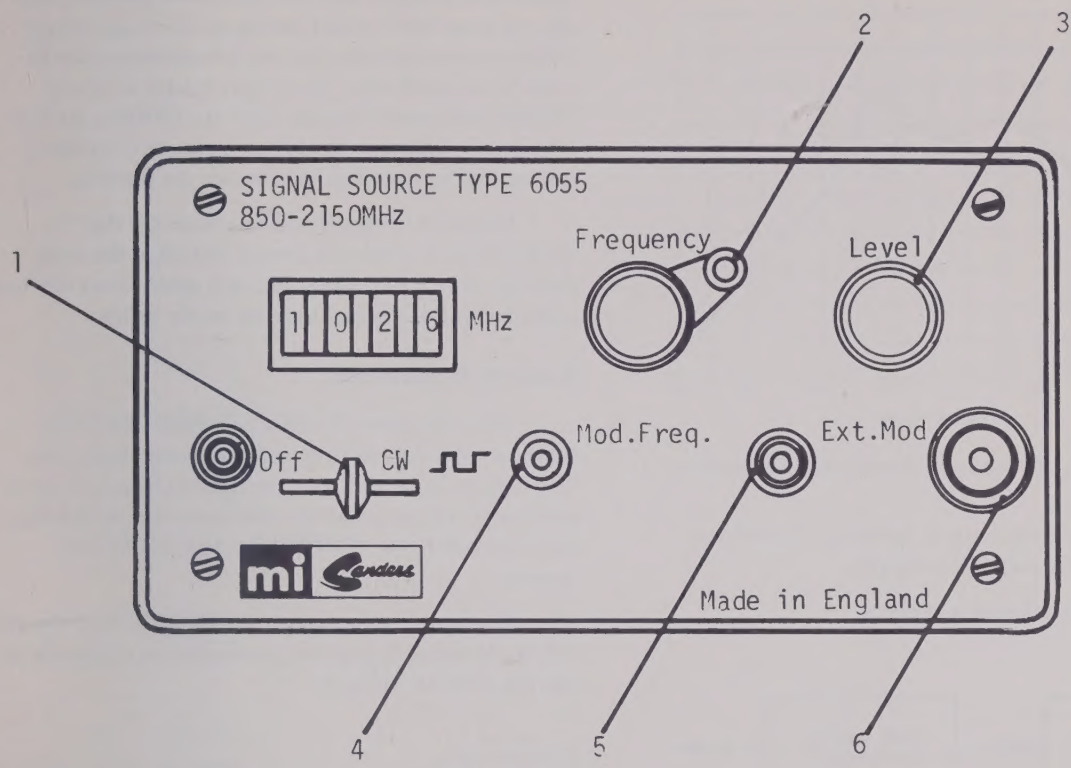

Fig. 2. Control Panel

2.1 OPERATING INSTRUCTIONS

The Type 6055 Signal Source can be operated in the following modes:

1) As a c.w. source of microwave power.
2) As an internally square wave modulated source in the range 900 – 1100Hz.
3) As an externally modulated source with an r.f. rise time of less than one microsecond.

The control functions are identified in Fig. 2.

1) Function Switch –
   For c.w. output set to c.w.
   For square wave modulation set to ⎍⎍
   The panel lamp indicates a.c. power in each case.
2) Frequency Control –
   Set to the desired frequency as indicated on the front panel counter.
3) R.F. Level Control –
   This can be used to set the r.f. output level. The maximum attenuation is greater than 25dB with the control set fully clockwise.
   For external inputs switch fully anticlockwise to the EXTERNAL MODULATING position.
4) Modulating Frequency Control –
   This control is used to set the internal modulating frequency between 900 and 1100Hz.
5) External Modulation Input –
   The front panel BNC socket allows access to the diode attenuator via a 220Ω series resistance. An input of -20V at approximately 90mA will attenuate the r.f. output by more than 25dB.
6) R.F. Output –
   The r.f. output is connected via a d.c. isolating capacitor to the front panel "N" type connector. In addition to these controls there is a rear panel BNC connector which provides a 0–20V output directly proportional to frequency. This can be used to drive the X axis of an oscilloscope or X–Y recorder when making broadband measurements.

2.2 OUTPUT LEVELLING

The Type 6055 produces an output in excess of 10mW over the range 850 – 2150MHz. Typical variation of output power with frequency is shown in Fig. 3.

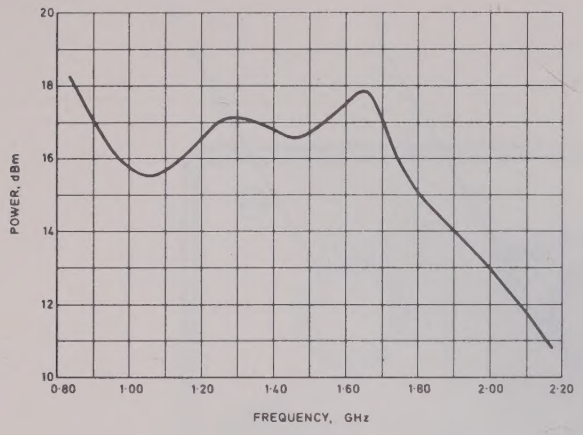

Fig. 3. Output Power as a Function of Frequency

The power output can be levelled to 10mW over the range using the internal modulator.

The circuit required is in Fig. 4.

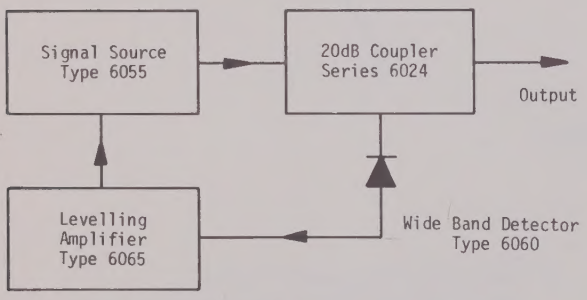

Fig. 4. Levelling Circuit with Type 6065 Levelling Amplifier

Alternatively, if a levelling amplifier is not available, the MI-Sanders Microwave Power Meter Type 6598, which has a rear panel output proportional to r.f. power can be used, in this case the circuit is as Fig. 5.

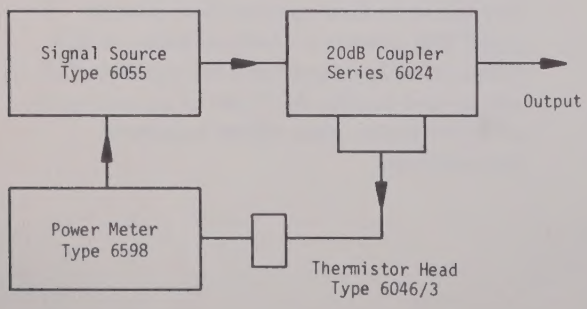

Fig. 5. Levelling Circuit with Microwave Power Meter Type 6598

Broadband Measurements

The type 6055 can be used in conjunction with an X–Y recorder to provide a permanent record of broadband measurements. When used in this mode the source is operated in a similar way to a Microwave Sweeper, with the rear panel BNC socket providing the sweep voltage. Reflectometer and insertion loss measurements can be made in the usual way. The output voltage is zero at 850MHz and approximately –20V at 2150MHz. As it is intended for high impedance input circuits (>100kΩ), heavier loading than this will degrade the linearity.

Maximum accuracy will be achieved if the 'FREQUENCY' control is always rotated in the same direction during the sweep. This will avoid errors due to a small amount of residual backlash in the system.

External Modulation

The front panel 'EXTERNAL MODULATING' socket provides access to an internal diode attenuator. This input is in parallel with the 'LEVEL' control, but is directly connected when the level control is turned fully anticlockwise to the 'EXTERNAL MODULATING' position.

The input voltage must not exceed –22V or the diode will be damaged. A graph of attenuation as a function of current is shown in Fig. 6.

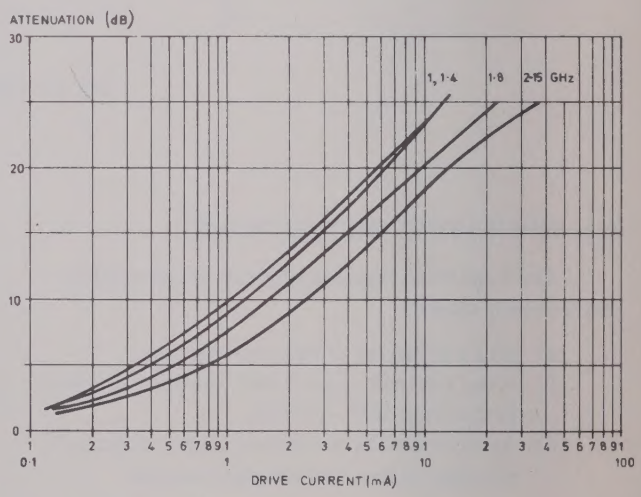

Fig. 6. Attenuator Response

The frequency response of the modulator is limited by the rise time of the input circuitry. In this case, the rise time when driven from a high impedance source is less than 1 microsecond. Faster rise times can be achieved by driving the diode with shaped pulses.

The diode attenuator represents a severe mismatch above about two or three dB attenuation, and hence some frequency pulling must be expected. This pulling has been reduced to about 2 or 3MHz (typical) by coupling fairly lightly into the cavity.

In applications where it is important to maintain frequency stability with a varying load mismatch, it is recommended that about 10dB of attenuation should be introduced by the front panel control. This will reduce the pulling to an insignificant level. Alternatively, an isolator or large value attenuator may be put in series with the r.f. signal.

Chapter 3

Technical description

3.1 MICROWAVE OSCILLATOR

The microwave generator consists of a transistor oscillator operating in the grounded collector mode. The resonant frequency is varied by capacitatively loading a transmission line in the base collector circuit. The capacitance consists of a short circuit line of variable length capacitatively coupled to the resonator line. This length is varied by a cam connected to the front panel frequency control. A combination of capacitor design and cam shaping allows a linear relation between frequency and the front panel dial reading.

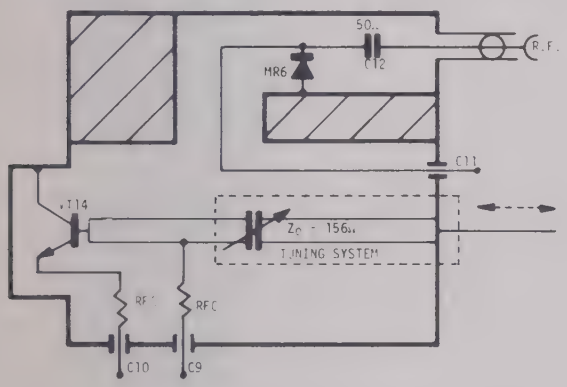

Fig. 7. Microwave Oscillator Schematic Diagram

3.2 DIODE ATTENUATOR

A PIN diode is mounted in the 50Ω output line. Bias is applied via the coupling loop which is a.c. grounded to the cavity wall. This bias is isolated from the r.f. line by a 330pf series capacitance.

At microwave frequencies the diode behaves like a shunt resistance whose value can be varied by the d.c. current passing through the device.

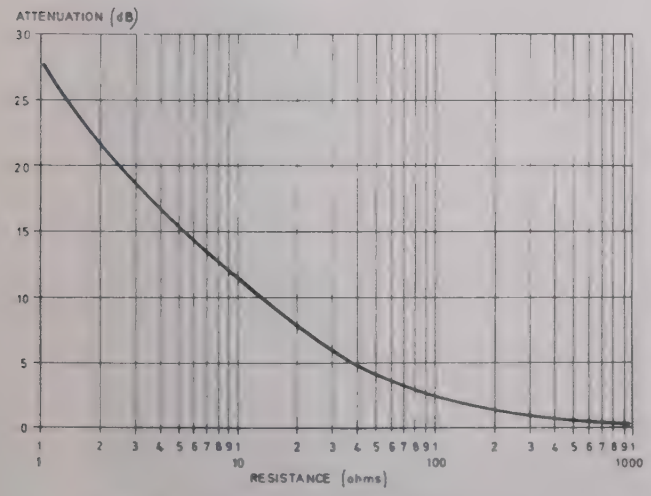

Fig. 8. Insertion Loss as a Function of Shunt Resistance in a 50Ω Line

The maximum attenuation which can be introduced depends on the parasitic resistance of the diode. In this case the residual resistance is about 1Ω corresponding to about 30dB attenuation for about 100mA foward bias. This is modified somewhat due to the compensating elements used to keep the diode impedance resistive. The main consequence of these elements is that the attenuation varies with frequency.

3.3 POWER SUPPLY AND SQUARE WAVE MODULATOR

Transformer, Rectifier – Filter

The transformer T1 has two primaries which, by operation of switch SW1, may be connected in parallel for 115 V supply and in series for 240 V supply. The centre-tapped secondary provides approximately 30-0-30 V

Current from the transformer secondary is rectified by diodes MR4 and MR5 and smoothed by capacitors C7 and C8. A 'MAINS' on indicator lamp 'ILP1' is energised by the transformer secondary.

Regulator Reference and Oscillator Supply

The supply provided by the circuit described in the preceeding section is unstabilised and partly smoothed. From this it is necessary to obtain a stable, smooth d.c. reference source for the regulator and a centre-tapped supply for the oscillator.

Components VT1, R2 and ZD4 together comprise a constant current circuit. A complementary arrangement comprising VT2, R1 and ZD1 provides another constant current. Interconnection of the two produces an arrangement which exhibits a very high rejection of supply ripple. The junction of R3 and R4 which are connected across ZD4 is used for the reference voltage and is approximately 2.5 V.

An additional diode ZD2 is inserted to provide 5–0–5 V across ZD1 and ZD2 in order to energise the modulator oscillator.

Regulator

Drive current for the regulator is provided by the constant current arrangement controlled by VT5. Transistors VT6 and VT7 provide current amplification. A proportion of the output voltage at the wiper of RV1 is compared with the reference voltage via the long tailed pair VT3 and VT4. Current drawn by VT4 collector diverts VT5 current from VT6. Thus the regulator exhibits negative feedback.

Capacitors C3 and C4 are necessary for regulator stability and noise reduction at the output. Diodes MR1 and MR2 are included to reduce the turn-off time when the output is modulated.

Ripple current is injected into the regulator loop at the base of VT4 via R8 from RV2; the setting being adjusted to reduce the ripple in the output to less than 1mV.

3.4 MODULATOR OSCILLATOR

Transistors VT8 and VT9, together with the associated resistors comprise a bi-stable switch, the output of which controls the two constant current circuits controlled by VT11 and VT12. The difference of the two currents charges capacitors C5 and C6. A signal is fed back from the capacitors to the bi-stable switch thus completing an oscillatory closed loop whose period of oscillation is determined by the current difference and the capacitor size. The capacitors may be connected in parallel for 1kHz or in series for 3kHz. Frequency adjustment is effected by RV3.

During oscillation transistor VT10 is alternately turned 'ON' and 'OFF' thus causing the output from the power supply to rise and fall between zero and the pre-set level.

Chapter 4

Maintenance

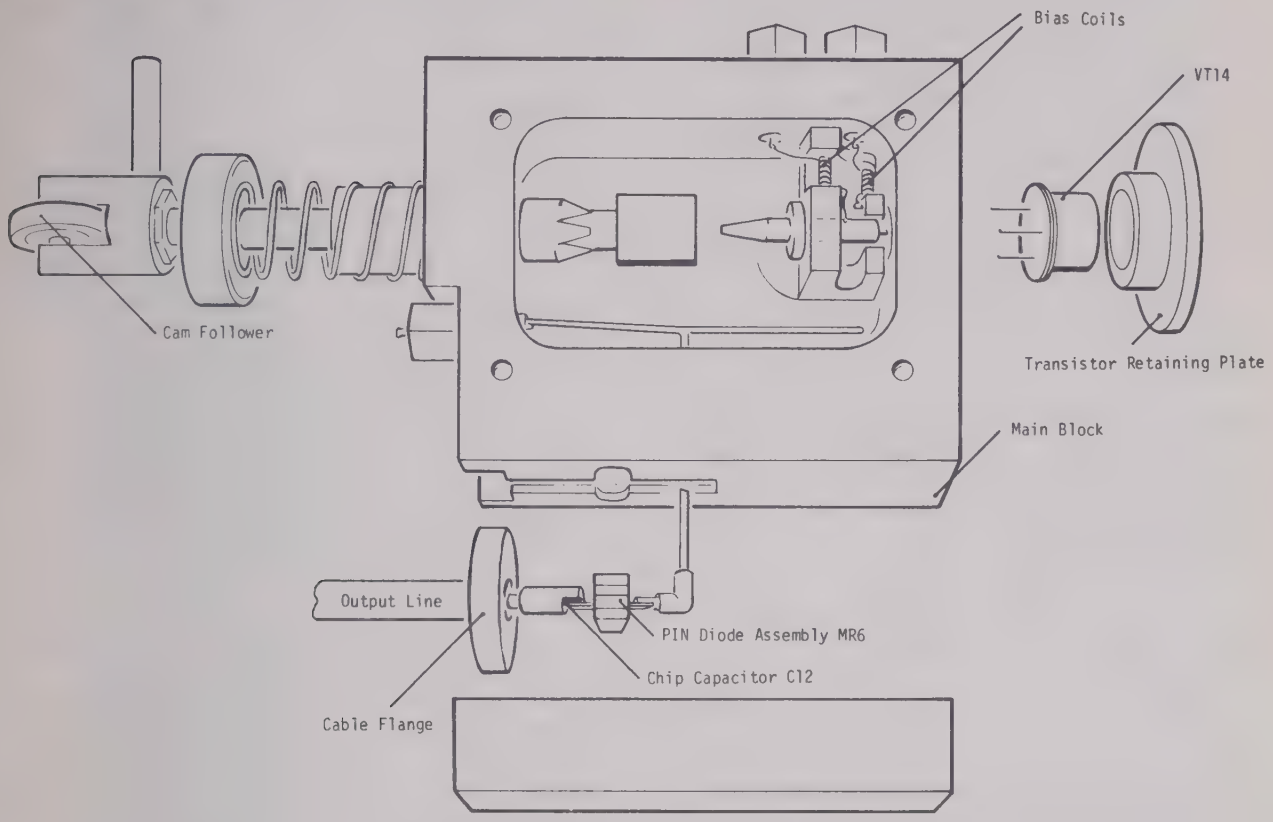

Fig. 9. Exploded view

4.1 POWER SUPPLY AND MODULATOR

The power supply and square wave modulator are located on the main board (Fig. 14). Components for the modulator drive circuit and the attenuator limiting resistor are mounted on a small board beneath the supply board.

No special techniques are required for servicing these circuits. It should be noted however that the unit should be recalibrated if any of the components biasing the microwave transistor are changed. Recalibration will, of course, be required if the microwave transistor is changed.

4.2 MICROWAVE UNIT

There are only two elements in the microwave unit which are likely to require replacement. They are the transistor and the PIN diode.

Diode Replacement

The PIN diode attenuator will have an indefinite lifetime provided the external input is not overloaded. Should this device fail it can be readily replaced in the following way (Fig. 9).

1) The oscillator block is split where the cable connector is attached. Two screws hold the cable flange into the main block, and one is screwed into the smaller block. Remove this screw ONLY.
2) Remove the four screws which hold the smaller block on to the main block.
3) Remove the smaller block. This will expose the PIN diode mounting assembly. Remove the two screws holding this smaller assembly. Remove the top two plates. The diode assembly can be removed by unsoldering the two diode tabs. Remove the chip capacitor.
4) Substitute a new chip capacitor taking care not to short it out.
5) Insert the replacement diode and solder the tabs on each side. Replace the packing pieces.
6) Replace the block cover and various retaining screws.

Transistor Replacement

The microwave transistor should not need replacement under normal operating conditions, as it cannot be damaged by mismatching the r.f. connector. If however it should fail for any reason, it is possible to replace it, in which case the unit will require recalibration.

It is recommended that the unit should be returned to the factory for this replacement, but if this is not practical the following procedure is recommended.

1) Remove the outer case.
2) Remove the screws retaining the main board and push it to one side.
3) Remove the top plate from the oscillator body.
4) Remove the round pressure plate from the back – this will expose the transistor.
5) Unsolder the leads and pull the transistor out, taking care not to damage the epoxy resin block or the bias coils.
6) Insert the replacement transistor, and make sure that it seats properly at the bottom of its recess. (Prior to fitting the small tab on the case next to the emitter must be removed).
7) Reassemble the cavity.
8) Calibrate.

NOTE: The transistors and cams are matched at the factory during assembly. Because of this not all transistors will give 1% accuracy with all the cams, although most of them can be made to fit using the adjustment on the follower.

4.3 TEST AND INSPECTION PROCEDURE

Test Equipment

The following units will be required to test the type 6055 signal source:

MI-Sanders Power Meter Type 6598	
MI-Sanders Thermistor Head Type 6046/3	
Comb Generator	– 800 – 2200MHz 10 and 100MHz. steps.
Spectrum Analyser	– 800 – 2200MHz markers
Power Supply	– 0.5 amp 0 – 25V
Voltmeter	– 0 – 25V
Oscilloscope	– 1mV/cm
X-Y Recorder	– 100mV/cm X and Y
MI-Sanders Coaxial Attenuator Type 6035	

Power Supply

IMPORTANT: Before switching on check that the unit is set to the correct mains voltage and that the correct fuse (250mA) is fitted.

Disconnect the small board and oscillator from the main board for this check.

Output Voltage

Connect a 5W 82Ω resistance across terminals 'M' and 'N'.

Switch mains on and vary RV1 until there is 22V across 'M' and 'N'.

Ripple

Connect an oscilloscope across terminals 'M' and 'N' and verify that the ripple is less than 1mV peak to peak.

Square Wave Modulation

Connect a 12k resistor from terminal 'C' to terminal 'N'.

Connect an oscilloscope across terminals 'C' and 'N' and check that there is a square wave when S2 is set to ⎍⎍⎍. Vary RV3 and check that the frequency can be set from 900Hz to 1100Hz.

Frequency Calibration

1) Set the counter and end stops to read 850MHz.
2) Turn the cam on the shaft until the calibration line coincides with the contact point of the follower. Tighten the fixing nut firmly.
3) Connect the circuit shown in Fig. 10. Set the comb generator to 10MHz increments and set the spectrum analyser to 850MHz.
4) Adjust the follower screw until the signal blip coincides with the 850MHz blip from the comb generator. Lock in place.
5) Switch the comb generator to 100MHz increments.
6) Set the spectrum analyser to 900MHz and switch to 30MHz/cm.
7) Turn the crank knob to line the signal up with the 900MHz blip on the screen. Turn down to 3MHz/cm. and repeat.
8) Check that the reading is within ± 1% i.e. ± 9MHz. Note down the counter reading.
9) Repeat at intervals of 100MHz up to 2100MHz. Check that the reading is within ± 1% in all cases.
10) Set the comb generator to 10MHz intervals, and set the spectrum analyser to 2150MHz. Expand the scale to 3MHz/cm. and identify the 2150MHz blip. Turn the crank knob to coincide with this blip. Check the reading is within ± 1%.

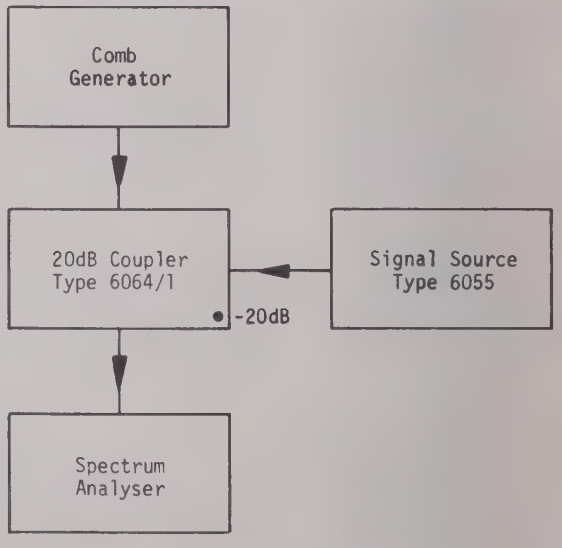

Fig. 10. Frequency Calibration Circuit.

Procedure in Case of Failure

If the readings are consistently low the push rod must be withdrawn slightly from the cavity. If the readings

are all high the push rod must be inserted further into the cavity. Turn to the frequency at which the maximum deviation occurs. Turn the adjuster knob on the follower until the unit is inside the specification.

Repeat the frequency checking procedure (7) – (10) but including 850MHz as well.

Harmonic Content

1) Turn the spectrum analyser to the 0.01 – 2.5GHz range.
2) With the unit turned to c.w. wind through from 850MHz to 2150MHz. Check all spurious outputs are more than 20dB down on the fundamental.

Power Output

Connect the circuit shown in Fig. 11.

1) Set the Microwave Power Meter Type 6598 to the 1mW range. (i.e. 100mW FSD with 20dB pad).
2) Set the level control to 'EXTERNAL'.
3) Switch to c.w. and set the counter to read 850MHz.
4) Wind through the range and ensure that the output power is in excess of 10mW from 850 to 2150MHz.

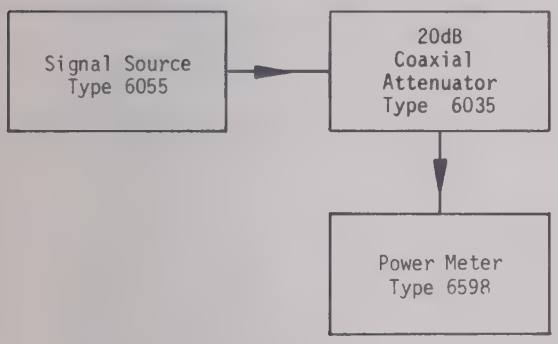

Fig. 11. Power Output Circuit

Pen Recorder Output

1) Connect the voltmeter set to 25V d.c. range across the rear panel BNC socket.
   The positive terminal should be connected to the outer, the negative terminal to the inner.
2) Set the counter to 850MHz. The voltmeter should read between 0 and 1V.
3) Wind through the frequency range; ensuring that the voltage increases steadily to a maximum of 17V at 2150MHz.

Attenuator Response

1) Set up the circuit shown in Fig. 12.
2) Connect the pen output to the X input of the recorder recorder and set the sensitivity to give f.s.d. for 20V.
3) Adjust the Y sensitivity to give f.s.d. for f.s.d. on the Microwave Power Meter Type 6598.
4) With the level control turned to 'EXTERNAL' wind through the range and obtain a power plot.
5) Turn the level control fully clockwise.
6) Remove 25dB of attenuation and repeat the power plot.
7) Check that this trace is below the original at all points.
8) Switch off. Set the level control to 'EXTERNAL' and connect the power supply (with the current limit set to 150mA) to 20V. Connect the positive terminal to the outer and the negative terminal to the centre of the 'EXTERNAL MODULATING' socket.
9) Switch on. Repeat the above plot. Check that the line is below the original calibration trace.

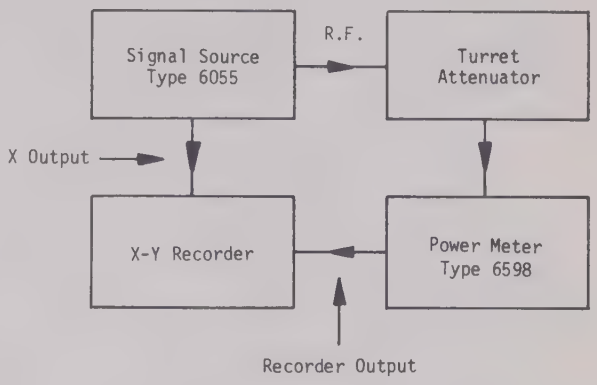

Fig. 12. Attenuator Calibration Circuit

Internal Modulation

1) Set up the circuit in Fig. 13. switch the unit to square wave.
2) Check that the output falls to the zero level for half the square wave.
3) Check the frequency can be varied from 900 to 1100Hz.

NB. Refer to circuit diagram and:-

For 1kHz internal modulation join G to H, F to E.
For 3kHz internal modulation join F to H.
Disconnect G and E.

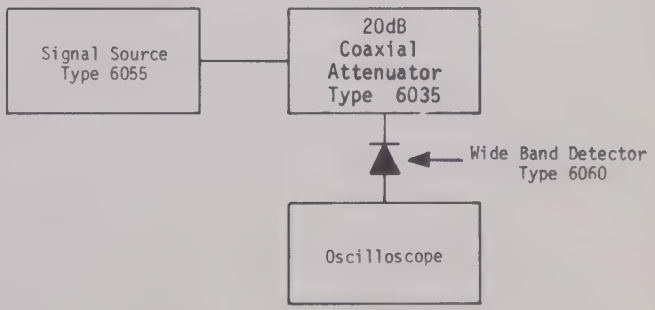

Fig. 13. Modulation Circuit

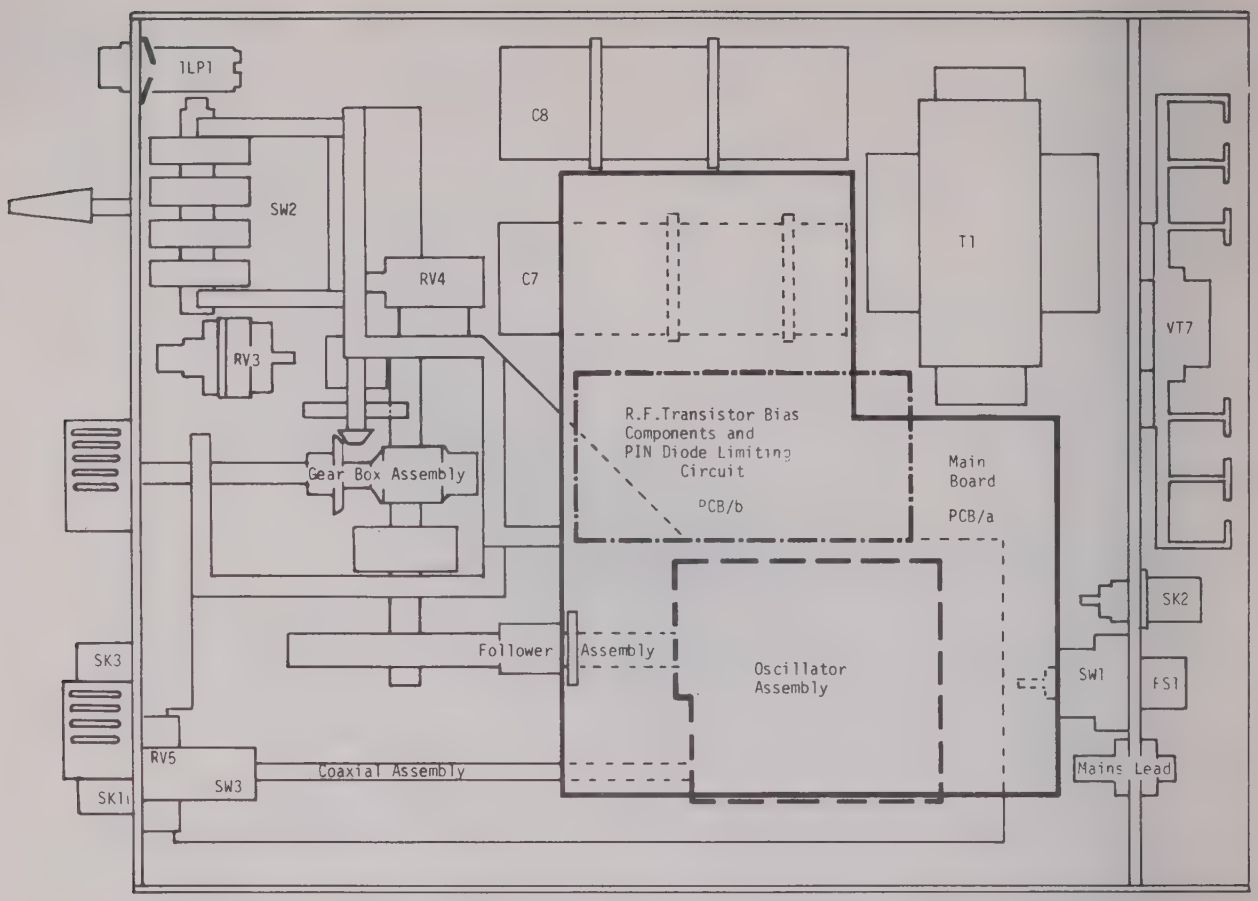

Fig. 14. Component Layout

Chapter 5

Replaceable parts

5.1 INTRODUCTION

This section list replaceable parts in order of circuit references. The following abbreviations and symbols are used:

BNC	:	bayonet-lock coaxial connectors	T	:	transformer
C	:	capacitor	VT	:	transistor
FS	:	fuse	WW	:	wirewound
ILP	:	indicator lamp	ZD	:	zener diode
Lin.	:	linear	μf	:	microfarad
Min.	:	miniature	V	:	volt
MR	:	semiconductor diode	W	:	watt
R	:	resistor	pf	:	picofarad
RV	:	resistor variable	Ω	:	ohms
SW	:	switch	kΩ	:	kilohms
SK	:	socket	MΩ	:	megohm

Ordering

Send your order for replacement parts to our Service Division. Specify the following information for each part required.

(1) Type and serial number of instrument.

(2) Circuit reference

(3) Description

Reference	*Description*	*Rating*	*Tolerance*	*Manufacturer*	*Part No.*
CAPACITORS					
C1	Capacitor Fixed 0.01μF	250V	20%	Mullard	344-40103
C3	Capacitor Fixed 0.1μF	250V	20%	Mullard	344-40104
C4	Capacitor Fixed 0.001μF	400V	10%	Mullard	C296-AC/A1K
C5	Capacitor Fixed 0.0015μF	350V	1%	Lemco	Silvermica Type MR2515
C6	Capacitor Fixed 0.0015μF	350V	1%	Lemco	Silvermica Type MR2515
C7	Capacitor Fixed 800μF	64V		Mullard	C431-BR/H800
C8	Capacitor Fixed 800μF	64V		Mullard	C431-BR/H800
C9	Feed Through Capacitor			Erie	Filtercon Type 1201-052
C10	Feed Through Capacitor			Erie	Filtercon Type 1201-052
C11	Feed Through Capacitor			Erie	Filtercon Type 1201-052

Reference	*Description*	*Rating*	*Tolerance*	*Manufacturer*	*Part No.*
C12	Capacitor Chip Ceramicon 330pf.	50V	10%	Erie	8300–002 Y5D
DIODES					
MR1	Semiconductor Diode			Texas Instruments	1S920
MR2	Semiconductor Diode			Texas Instruments	1S920
MR3	Semiconductor Diode			Texas Instruments	1S920
MR4	Semiconductor Diode			Texas Instruments	1S101
MR5	Semiconductor Diode			Texas Instruments	1S101
MR6	P.I.N. Diode	–	–	–	–
ZD1	Zener Diode			Mullard	BZY88/C5V6
ZD2	Zener Diode			Mullard	BZY88/C5V6
ZD3	Zener Diode			Mullard	BZY88/C5V6
ZD4	Zener Diode			Mullard	BZY88/C5V6
RESISTORS					
R1	Resistor Fixed 820Ω	¼W	2%	Welwyn Metox	MR4
R2	Resistor Fixed 820Ω	¼W	2%	Welwyn Metox	MR4
R3	Resistor Fixed 2.7kΩ	¼W	2%	Welwyn Metox	MR4
R4	Resistor Fixed 2.2kΩ	¼W	2%	Welwyn Metox	MR4
R5	Resistor Fixed 820Ω	¼W	2%	Welwyn Metox	MR4
R6	Resistor Fixed 2.7kΩ	¼W	2%	Welwyn Metox	MR4
R7	Resistor Fixed 4.7kΩ	¼W	5%	Welwyn Metox	MR4
R8	Resistor Fixed 100kΩ	¼W	5%	Welwyn Metox	MR4
R9	Resistor Fixed 100Ω	¼W	5%	Welwyn Metox	MR4
R10	Resistor Fixed 4.7kΩ	¼W	5%	Welwyn Metox	MR4
R11	Resistor Fixed 150Ω	¼W	2%	Welwyn Metox	MR4
R12	Resistor Fixed 1kΩ	1W	5%	Welwyn Metox	MR6
R13	Resistor Fixed 68kΩ	¼W	5%	Welwyn Metox	MR4
R14	Resistor Fixed 6.8kΩ	¼W	5%	Welwyn Metox	MR4

Reference	*Description*	*Rating*	*Tolerance*	*Manufacturer*	*Part No.*
R15	Resistor Fixed 22kΩ	¼W	2%	Welwyn Metox	MR4
R16	Resistor Fixed 820kΩ	½W	2%	Welwyn Metox	MR5
R18	Resistor Fixed 470kΩ	½W	2%	Welwyn Metox	MR5
R19	Resistor Fixed 47kΩ	¼W	2%	Welwyn Metox	MR4
R20	Resistor Fixed 47kΩ	¼W	2%	Welwyn Metox	MR4
R21	Resistor Fixed 150kΩ	¼W	2%	Welwyn Metox	MR4
R22	Resistor Fixed 150kΩ	¼W	2%	Welwyn Metox	MR4
R23	Resistor Fixed 33kΩ	¼W	2%	Welwyn Metox	MR4
R24	Resistor Fixed 33kΩ	¼W	2%	Welwyn Metox	MR4
R25	Resistor Fixed 33kΩ	¼W	2%	Welwyn Metox	MR4
R26	Resistor Fixed 4.7kΩ	5W	1%	Welwyn Metox	W21
R27	Resistor Fixed 3.9MΩ	¼W	2%	Welwyn Metox	C21
R28	Resistor Fixed 470Ω	½W	10%	Radiospares	Moulded Carbon
R29	Resistor Fixed 2.7kΩ	½W	10%	Radiospares	Moulded Carbon
R30	Resistor Fixed 10kΩ	½W	10%	Radiospares	Moulded Carbon
R31	Resistor Fixed 1.5kΩ	1W	10%	Radiospares	Moulded Carbon
R32	Resistor Fixed 560Ω	1W	10%	Radiospares	Moulded Carbon
R33	Resistor Fixed 56Ω	1W	10%	Radiospares	Moulded Carbon
R35	Resistor Fixed 1kΩ	¼W	10%	Radiospares	Sub MIN-HYSTAB
R36	Resistor Fixed 220Ω	2W	10%	Radiospares	Moulded Carbon
R37	Resistor Fixed 470Ω	¼W	10%	Erie	Type 109
R38	Resistor Fixed 100kΩ	$^1/_8$W	5%	Mullard	B803104NB

Reference	*Description*	*Rating*	*Tolerance*	*Manufacturer*	*Part No.*
R39	Resistor Fixed 1.5kΩ	$^1/_8$W	5%	Mullard	B803104NB
R40	Resistor Fixed 4.7kΩ	$^1/_8$W	5%	Mullard	B803104NB
R50	Resistor Fixed 1.2kΩ	¼W	2%	Welwyn Metox	
RESISTORS VARIABLE					
RV1	Resistor Variable 50Ω Linear WW			Welwyn Metox	P25
RV2	Resistor Variable 5kΩ Linear WW			Welwyn Metox	P25
RV3	Resistor Variable 100kΩ Linear	¼W		Morganite	Type U $^5/_8$"
RV4	Resistor Variable 20kΩ Linear	¼W		Colvern	CLR1106/95
RV5	Resistor Variable 25kΩ Log with SPST on/off switch SW3			Colvern	CLR3901/22
TRANSISTORS					
VT1	Transistor			Fairchild	C424
VT2	Transistor			Mullard	BCY30
VT3	Transistor			Fairchild	C424
VT4	Transistor			Fairchild	C424
VT5	Transistor			Mullard	BCY30
VT6	Transistor			Fairchild	C424
VT7	Transistor			Texas Instruments	2S033
VT8	Transistor			Fairchild	V435
VT9	Transistor			Fairchild	C424
VT10	Transistor			Fairchild	V435
VT11	Transistor			Fairchild	V435
VT12	Transistor			Fairchild	C424
VT13	Transistor NPN			Texas Instruments	2N696
VT14	Transistor				
TRANSFORMER					
T1	Transformer			MI-Sanders	B3510/T530
SWITCHES					
SW1	Switch Slide			Radiospares	
SW2				MI-Sanders	A2564/047
SW3	Part of RV5				
INDICATOR LAMP					
1LP1	Indicator Lamp			Thorn	SGF9/A/RED/24

Reference	*Description*	*Rating*	*Tolerance*	*Manufacturer*	*Part No.*
SOCKETS					
SK1	Type N Connector			MI-Sanders	
SK2	BNC Socket			Greenpar	GE35063
SK3	BNC Socket			Greenpar	GE35063
FUSE					
FS1	Fuse 20mm x 5mm Glass			MI-Sanders	
	Fuse Holder 20mm Min. Panel			Radiospares	
MISCELLANEOUS					
	Crank Knob			MI-Sanders	

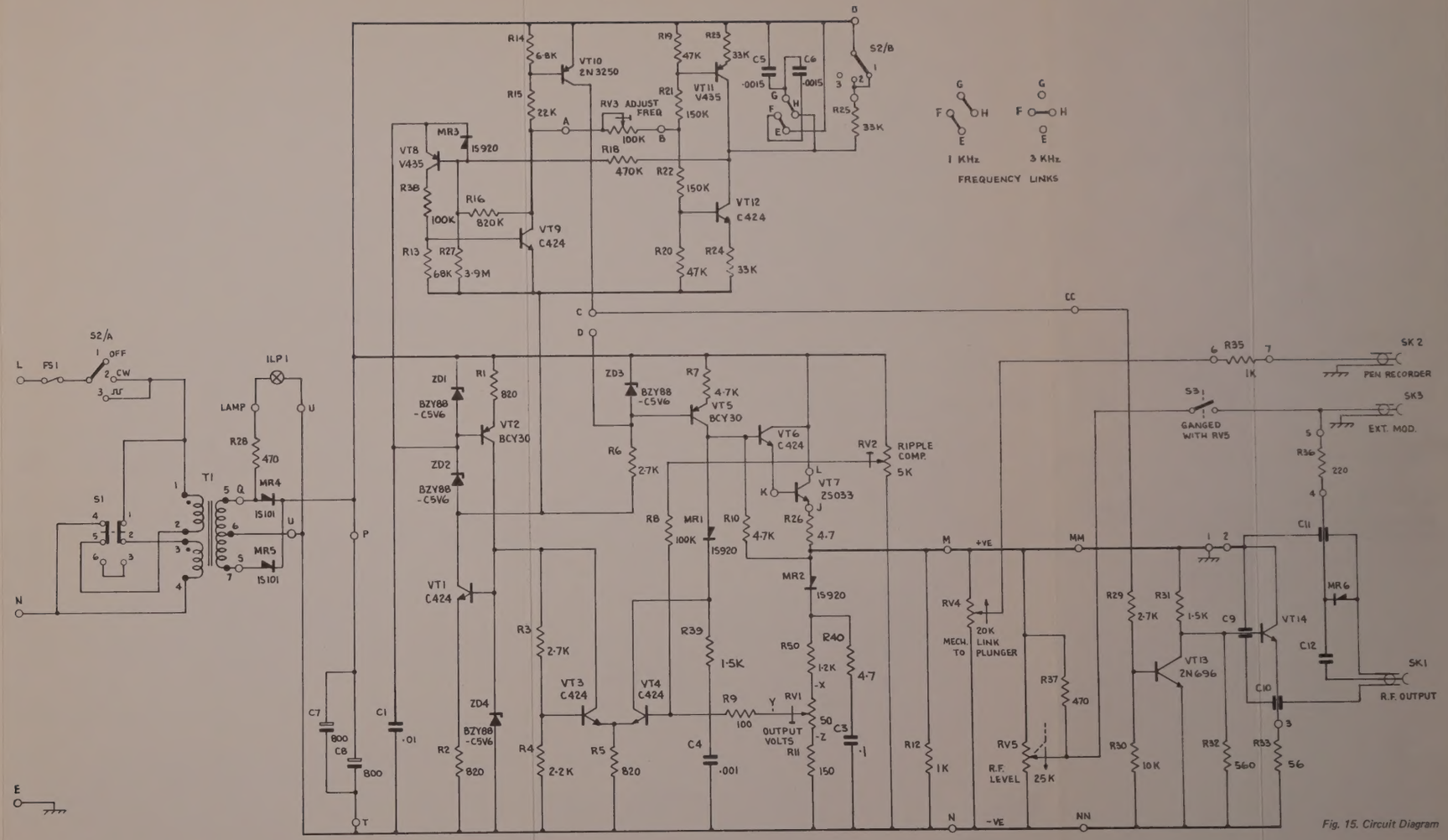

Fig. 15. Circuit Diagram

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